

Automotive and Aerospace

- New Gas Standards for Calibrating Instrumentation used for Measuring Emissions from Next Generation Low Emission Vehicles
- Gas Mixtures for the Automotive Industry: The NTRM Prime Program

Program: Automotive and Aerospace

Title: New Gas Standards for Calibrating Instrumentation used for Measuring Emissions from Next Generation Low Emission Vehicles

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Abstract: Stakeholders in the American Industry/Government Emissions Research (AIGER) group are working together to facilitate the automobile industry meeting more stringent 2003 Federal Tier II and California LEV II emission regulations. AIGER members include the U.S.EPA, California Air Resources Board (CARB), General Motors, Ford, and Daimler-Chrysler. In 1998, NIST worked with a Specialty Gas contractor to blend two cylinders each of low NO standards at concentrations of 0.5 $\mu\text{mol/mol}$, 0.75 $\mu\text{mol/mol}$, 0.95 $\mu\text{mol/mol}$, 1.05 $\mu\text{mol/mol}$ and 1.25 $\mu\text{mol/mol}$. The new standards have exhibited excellent NO concentration stability for more than 5 years and final concentration values with associated uncertainties have been recently assigned. In 2001, AIGER provided direct funding to a NIST contractor to work jointly with NIST to produce two new low NO SRMs at concentrations of 0.5 $\mu\text{mol/mol}$ and 1.0 $\mu\text{mol/mol}$. NIST and its contractor followed the “roadmap” used to prepare the ten low NO working Standards to blend forty cylinders of 0.5 $\mu\text{mol/mol}$ and forty cylinders of 1.0 $\mu\text{mol/mol}$ NO in nitrogen. Twenty-seven candidate cylinders of each new SRM (54 total) were given to NIST in January, 2002 to begin SRM certification analyses, which as of September, 2004 have been completed. The data analysis and completion memo should be issued by late December, 2004.

Purpose: NIST and the U.S. Motor Vehicles Manufacturers have worked together since 1975 to develop sixty (60) gaseous Standard Reference Materials, which are the Nation’s benchmarks against which all U.S. EPA mandated fuel economy and mobile source emission measurements must be traceable; by federal law. NIST currently supports AIGER members by maintaining reasonable inventories of required gas SRMs that consist of dilute mixtures of key pollutants such as hydrocarbons, carbon monoxide and nitric oxide. Newer vehicles produce lower levels of these pollutants because their engines employ fuel injection whose air to fuel ratio is optimized by an on-board computer, and their emissions are further reduced by more efficient catalytic converters. During testing the exhaust levels are diluted by the use of constant volume sampling bags or by new mini-diluter technology. AIGER stakeholders have identified the need for significantly lower NIST gas standards containing carbon monoxide, hydrocarbons and nitric oxide; with the completion of SRM 2737 (0.5 $\mu\text{mol/mol}$) and SRM 2738 (1.0 $\mu\text{mol/mol}$) nitric oxide in nitrogen being their highest priority. NIST is currently exploring working standards below 0.1 $\mu\text{mol/mol}$.

Major Accomplishment: NIST has assigned final values and uncertainties to ten low NO working standards after monitoring their stability for more than five years. These stable NIST working standards were then used to plot NO and NO_x calibration curves against which NO and NO_x concentrations were assigned to twenty-seven candidate SRM 2737 (0.5 $\mu\text{mol/mol}$ NO) cylinders and twenty-seven candidate SRM 2738 (1.0 $\mu\text{mol/mol}$ NO) cylinders with final values assigned in September, 2004; two years after blending. All candidate SRM cylinders were observed to be stable.

The new SRMs will be completed by December 31, 2004.

Impact: The project has developed a technical solution to NIST's long standing low NO SRM stability problems and provided AIGER members with interim standards to work with. Finally the project will provide too much needed lower concentration NIST certified NO SRMs in the next few months. These new SRMs will help facilitate vehicle manufacturers in meeting U.S.EPA and CARB's current and future lower emission regulations.

Future Plans: NIST will complete data analysis and report generation for SRM 2737 and SRM 2738 by December, 2004. NIST is continuing to move NO analytical standards and measurement capability lower to below 0.1 $\mu\text{mol/mol}$; defined as a high priority future requirement by AIGER.

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Title: Gas Mixtures Standards for the Automotive Industry: The NTRM Prime Program

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Abstract: The gas mixture NIST Traceable Reference Material (NTRM) program is a procedure for producing and certifying traceable calibration gas standards. Specialty Gas Companies produce, with concurrence from NIST, groups of identical gas mixtures in cylinders, minimum of 10, analyze them and send the data to NIST which then selects 10% of the group to be sent to NIST for analysis. The group of cylinders is assigned one concentration value and uncertainty by using the data generated by NIST for concentration determination and the NIST and Producer data to determine the uncertainty. These NTRM mixtures are under the prevue of the Producer, or Specialty Gas Company, to be sold as traceable standards or to be used at the Producer facilities to analyze other mixtures that are then sold as traceable mixtures. There have been requests, specifically from the automotive industry, for NIST to provide NIST analyzed mixtures with lower uncertainties than NTRMs. A method of accomplishing this is for NIST to analyze each NTRM mixture of a specific group and provide a concentration and uncertainty for each specific cylinder; these would be known as NTRM Prime (NTRM).

Purpose: The Gas Mixture NTRM Program provides a mechanism to produce needed calibration gas standards on demand. Specialty Gas companies are in touch with end users who require traceable mixtures and inform the gas companies of their needs. If NIST has the infrastructure to certify the required standards then the Gas companies can produce the NTRM batch, have it certified by NIST and supply mixtures to meet the demand. Some end users require, one group being the auto industry, require pedigreed calibration standards with low uncertainty. The pedigree is required because of the need to comply with requirement in the Code of Federal Regulations (CFR), which specify that SRMs or NTRMs are to be used for instrument calibration for the measurement of vehicle exhaust emissions. Using an NTRM serves two purposes; (1) it is a calibration gas mixture specified in CFR and (2) it has a lower uncertainty than an NTRM since each mixture has individual concentration value and uncertainty, there are no batch statistics involved.

Major Accomplishments: NIST has met with representatives of the automotive industry requesting NTRM's and has defined a program to meet their needs. Members of the automotive industry will decide what gas mixtures are needed and then contact a NTRM producer to manufacture the total number of mixtures. NIST has already discussed this with the NTRM producers all of whom have stated that they will certainly cooperate with the needs of any industry or organization requiring NTRM's. After the NTRM mixtures are produced all of them will be sent to NIST for analysis after which a certificate will be issued for each individual cylinder and the cylinder sent to the company or organization requesting it.

Impact: A large number of gas measurements mandated by CFR require calibration standards traceable to NIST with low total uncertainty. Standards supplied by the SRM program are the most suitable but are not always available and are NIST resource intensive to provide. The normal NTRM program provides standards that by their nature are higher in uncertainty than the

SRMs. The NTRM program provides a mechanism to provide required calibration gas standards in a timely fashion with NIST traceability and a low total uncertainty.

Future Plans: To support the need for NTRM material, NIST plans to increase the number and concentration ranges of gas species for which it maintains primary standards, which are the foundation of the program. A meeting is to be held at 2005 Pittsburgh Conference in Orlando, FL to which all interested parties are invited, NTRM Producers, regulating bodies and end users, to describe the program and to obtain and evaluate comments and suggestions.